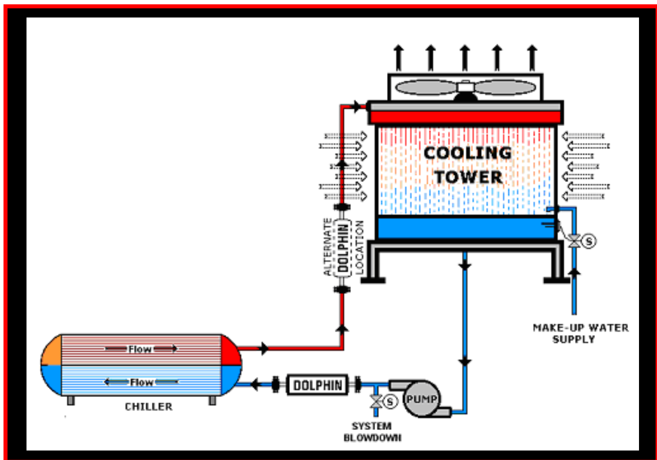
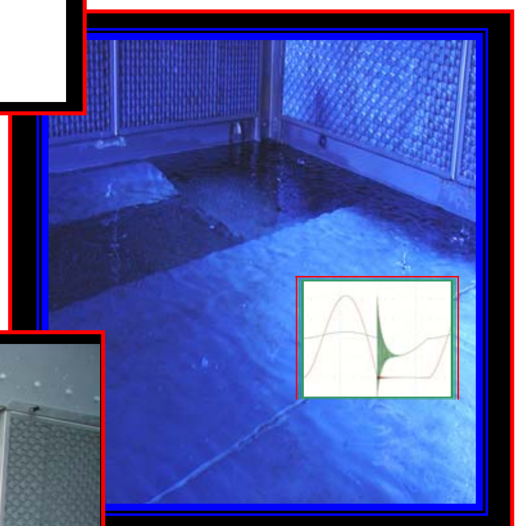
Customer Advanced Technologies Program

Pulse-Power Water Treatment Systems for Cooling Towers





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Sacramento Municipal Utility District
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About the Customer Advanced Technologies Program

SMUD's Customer Advanced Technologies (C.A.T.) program works with customers to encourage the use and evaluation of new or underutilized technologies. The program provides funding for customers in exchange for monitoring rights. Completed demonstration projects include lighting technologies, light emitting diodes (LEDs), residential building shell construction, geothermal heat pumps, indirect / direct evaporative cooling, non-chemical water treatment systems and a wide variety of other technologies.

For more program information, please visit: http://www.smud.org/education/cat/index.html

Introduction

"Pay me now or pay me later…"

It's another scorching summer day in Sacramento. The local weather forecaster is calling for yet another 103°F day – the fourth time this week. The phone starts ringing – people from all parts of the building are calling to tell you that the air conditioning system is broken (again). With a heavy sigh, you grab your tool belt and head outside to check on the chiller. Outside, an idle chiller and a slimy, scale-encrusted cooling tower greet you. As you look over the system, the words of the cooling tower salesman echo in your head once again, "Remember to keep up on your water treatment program."

People choose to install water-cooled cooling systems for good reasons: they are twice as energy efficient, quieter and last longer than their air-cooled counterparts. However, if the water is not treated properly, these systems can quickly become a maintenance nightmare. For decades, the industry has used chemicals to treat cooling towers and other water-cooled equipment. During this time, several non-chemical water treatment systems came and went. Some of these systems had limited success, while others utterly failed.

This technology report is about pulse-power water treatment systems and addresses the following questions: Why do we need water treatment? How do pulse-power water treatment systems work? Are they better than chemicals? Are they cost effective?

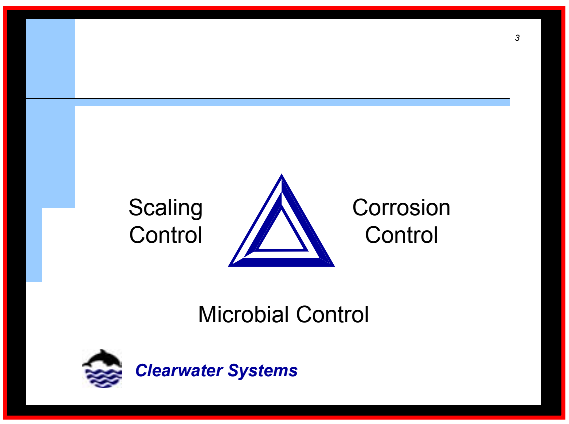
Water Treatment 101

A consistent, effective water treatment program is absolutely essential for cooling towers and other water-cooled equipment. Lack of proper treatment will eventually lead to serious problems including:

- ❑ Excessive equipment downtime & premature failure
- ❑ Occupant discomfort and complaints
- ❑ Possible health and safety issues
- ❑ High energy costs

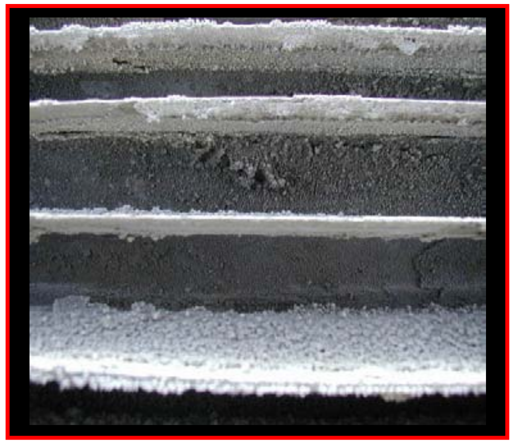
An ideal water treatment program would:

- ❑ Prevent scale formation on equipment surfaces
- ❑ Provide corrosion protection
- ❑ Control microbiological growth
- ❑ Minimize maintenance costs
- ❑ Minimize water consumption
- ❑ Be environmentally responsible



Source: Clearwater Systems (1)

Scale



Scale formations in a cooling tower.
Photo provided courtesy of BWI Solutions Inc.

Water usually contains several dissolved minerals including calcium carbonate $CaCO_3$ iron and silica. As long as these minerals stay in *suspension* (dissolved) they do not pose a problem to equipment. However, when water evaporates, the minerals are left behind. Eventually, the water becomes *supersaturated* and can no longer hold the minerals in suspension. When this happens, the minerals fall out of suspension (precipitate). Since minerals have a natural electrical charge, they are attracted to the metal surfaces of equipment and will form scale.

The mineral content of water is expressed in either parts per million (PPM) or total dissolved solids (percentage). Calcium carbonate or $CaCO_3$ will usually precipitate and form scale sooner than most other minerals. Because of this, equipment manufacturers usually provide guidelines for maximum $CaCO_3$ levels in their maintenance manuals. The table below depicts recommendations from Baltimore Air Coil, a well-known cooling tower manufacturer, for their Series 1500 towers.

Note: The allowable levels of $CaCO_3$ and other minerals will vary depending on site conditions, the type of equipment and the type of water treatment program being used. Customers should consult with equipment manufacturers and professional water treatment companies for specific recommendations.

Re-circulated Water Quality Guidelines

Baltimore Air Coil: Series 1500 Towers	Stainless Steel or BALTIBOND Corrosion Protection System	Galvanized Steel (G235)
pH	6.5 to 9.0	7.30 to 9.0
Hardness as $CaCO_3$	30 to 500 ppm	30 to 500 ppm
Alkalinity as $CaCO_3$	500 ppm max.	500 ppm max.
Total Dissolved Solids (TDS)	1,200 ppm max.	1,000 ppm max.
Chlorides	250 ppm max.	125 ppm max.

Source: www.baltaircoil.com

Note: these are general guidelines only and will vary depending on site conditions and the type of equipment. Customers should consult with their equipment manufacturer and professional water treatment company for specific recommendations.

Scale Prevention

There are three basic ways to help prevent scale from forming on cooling towers and water-cooled equipment: blow-down, chemicals and non-chemical water treatment systems. Note that both chemical and non-chemical methods must be combined with blow-down to maintain adequate control.

1) **Blow-down:** The concentration of minerals can be controlled through dilution by replacing some of the water in the tower basin with fresh water (aka make-up water). This process is called blow-down. The number of times water is re-circulated in a tower before being discharged to the sewer is expressed by the term *cycles of concentration*.

$$\textbf{Cycles of Concentration} = \frac{\text{mineral content of tower water}}{\text{mineral content of make-up water}}$$

   Although cycles of concentration set points will vary widely, they usually range from 2 to 4 cycles for most cooling towers. Operating a tower at over four cycles of concentration may be risky, while operating at lower levels wastes water and chemicals (if the tower is chemically treated).

2) **Chemical treatment:** A class of chemicals called *polymers* can be added to the water to help keep the minerals in suspension

3) **Non-chemical method:** Altering the electrical charge of the mineral particles so that they form ‘colloidal nucleating powder’ or crystals (more on this later). This technique causes minerals to ‘clump together’ (nucleate) rather than deposit onto the equipment surfaces. The minerals are subsequently carried off in the discharge water stream during blow-down.

Microbial Growth

Warm, moist environments are ideal for the production of bacteria, mold, slime and other organisms. If not properly controlled, these organisms may cause restricted airflow, clogged pumps, valves or filters and other problems. The amount of bacteria present in water can be measured and expressed in terms of CFU/ml. (colony forming units per milliliter). The goal for most chemically treated towers is a Total Bacteria Count of between 20,000 and 50,000 CFU/ml. Most experts agree that one of the best ways to help control biological growth is by keeping the cooling tower clean and free from scale and slime. This can be accomplished through the use of chemicals, exposure to electromagnetic energy and manual cleaning. However, if chemical bactericides are used, they are often species-specific and must be periodically switched to maintain adequate control.

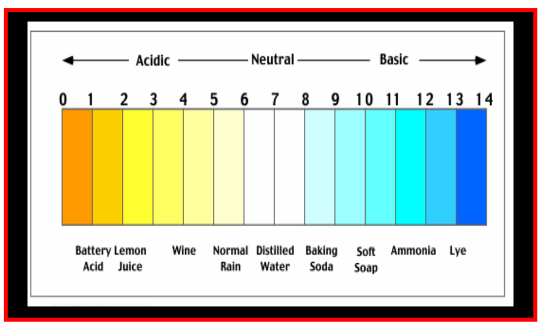
Photo provided courtesy of BWI Solutions Inc. (2)

Corrosion Protection

Oxidizing biocides (bromine, chlorine, ozone, etc.) are the most effective chemical biocides for controlling bacteria. Unfortunately, they are also very corrosive as can be seen in the picture below. The distribution deck of this cooling tower was completely eaten away near the access ladder because the treatment company was manually applying bleach at this location. Bleach is often used in competitive bid situations since it is very inexpensive. However, it is not very effective at the higher pH ranges at which most cooling towers systems are operated. It is very corrosive to both the internal tower components and the surrounding piping exposed to the vapor. Consequently, cooling towers and other equipment must be protected from corrosion.

Photo provided courtesy of BWI Solutions Inc (2)

Water is often referred to as the "universal solvent." It has an amazing ability to break down many different types of materials – including metals. The corrosiveness of water is determined by the number of hydrogen ions present and is measured using the *pH scale*. The term pH is derived from the mathematical symbol of the negative logarithm "p" and the chemical symbol of Hydrogen, "H." The pH scale ranges from 0 (highly acidic) to 14 (highly alkaline) and is logarithmic. Water with a pH value of 8 is ten times more alkaline than water with a pH of 7, and 100 times more than pH 6. Distilled water has a value of 7.0 and is said to be neutral.



Care must be taken to maintain the pH within acceptable ranges. If the pH is too low, the water will corrode un-protected metal components of the cooling system. If the pH is too high, scale may deposit onto the equipment surfaces. When using chemical treatment, phosphates, silicates or triazoles must usually be added to the water to offset the acidity of the biocides. Baltimore Air Coil recommends maintaining a pH range of 6.5 to 9.0 for stainless steel towers, and 7.3 to 9.0 for galvanized metal towers.

In the water treatment industry, corrosion of metal is measured in mils per year (mpy) using standardized tests (e.g. ASTM D 2688-94, Standard Test Methods for Corrosivity of Water in the Absence of Heat Transfer, Weight Loss Methods, Test Method A). Testing is accomplished by placing steel (C1010) and copper (CDA110) 'corrosion coupons' in a PVC rack with six coupon positions. The rack is installed into the conductivity controller sample stream of the cooling tower and the flow within the sample stream is regulated. Since corrosion rates are high initially and then fall to a lower, nearly constant rate, the corrosion coupons are retrieved and analyzed at short-term (5, 10 and 15-day) and long-term (30, 60 and 90-day) sample intervals. The short-term intervals are used to determine the rate at which passivity (formation of a protective layer) occurs. The long-term test intervals are used to determine the annual corrosion rate. The Cooling Technology Institute Guideline WPT-130 lists corrosion of 2-5mpy on mild steel as 'good' and 0-2mpy as excellent.

Environmental Concerns

Since water treatment chemicals ultimately end up going down the drain, cooling tower owners are facing increasing regulatory pressures from water and air quality protection agencies. Specifically:

- Biocides are classified as pesticides by law (Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); 7 U.S.C. s/s 135 et seq. (1972) and as such, are highly regulated substances. As pesticides, by federal and state law biocides require "application for hire" to be conducted by a licensed pest control company under the control of a technician holding a current qualified applicator license issued by the California Department of Pesticide Regulation. This license requires testing and follow-on educational credits to maintain. Furthermore, each company must register annually with the Agricultural Commissioners Office of each county where they conduct treatment operations and provide monthly pesticide use reports to the Agricultural Commissioner's Office. Some water treatment companies *provide* the biocides to their customers to apply, thus bypassing the "for hire" clause that triggers the need for licensing and reporting.

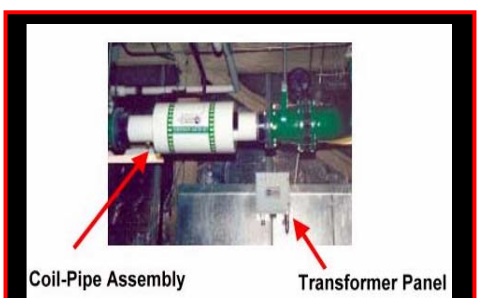
- Since biocides are classified as a hazardous substance, they require specialized training and personal protective equipment for anyone handling them.

- Biocides, phosphates and brines affect the operation of water treatment plants.

Technology Description: How Does It Work?

System Components

Pulse-power systems consist of two primary components: a high-frequency pulse generator (controller) and a reaction chamber. The controller uses proprietary electronic circuitry to induce a high frequency, time varying electromagnetic field into the circulating water via a reaction chamber. The reaction chamber (shown below) is essentially a section of stainless steel or PVC pipe wrapped with a solenoid coil. However, these coils are not merely a few turns of wire; they are very complex devices resulting from several years of experience. Manufacturers, such as Clearwater Systems, incorporate powerful magnets and microelectronics into the coil itself. This helps to ensure the water molecules are completely exposed to the pulsating electromagnetic field.

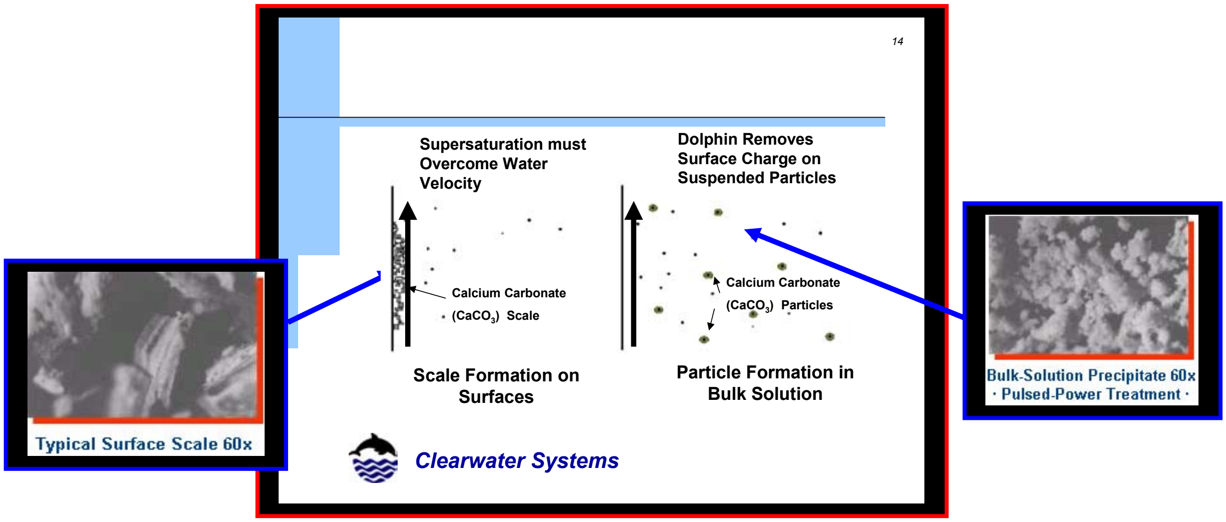


Source: Clearwater Systems (1)

Since the coil is on the outside of the pipe, there is no direct contact between the coil and the water. The preferred location for installing the reaction chamber is between the discharge side of the condenser water circulation pump and the chiller. However, the chamber may also be installed between the chiller and the cooling tower. For some applications, an additional chamber may also be installed on the incoming (makeup) water line.

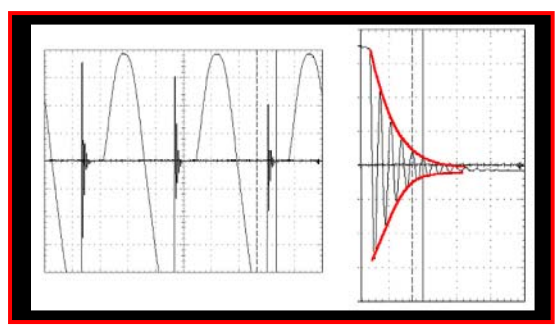
Preventing Scale

Pulse-power water treatment systems do not filter out or remove the minerals in water; they simply affect the way minerals precipitate out of solution by altering the electrical charge of the particles. In simple terms, exposing the water to varying electromagnetic energy causes minerals to 'clump together' (nucleate) rather than depositing onto the equipment surfaces. The minerals form 'colloidal nucleating powder' or crystals in 'bulk solution' that are subsequently carried off in the discharge water during blow-down.



Source: Clearwater Systems (1)

A few years ago, several efforts were made to treat water by using fixed, permanent magnets. Most of these attempts were unsuccessful. Subsequent experience has shown that the minerals must be exposed to a sufficient amount of electromagnetic energy to effectively treat the water. So far, one of the best ways to accomplish this task is to repeatedly expose the water to a pulsating electromagnetic field. According to the manufacturer, the intensity, frequency and pulsating action of the electromagnetic field is the key to effective water treatment. These wave-forms can be seen by using an oscilloscope (see photo at right). Because the magnetic fields are relatively weak, the water must be re-circulated though the system to receive adequate exposure. Fortunately, this is relatively easy to accomplish for cooling towers and similar applications by installing the reaction chamber in the condenser water loop.

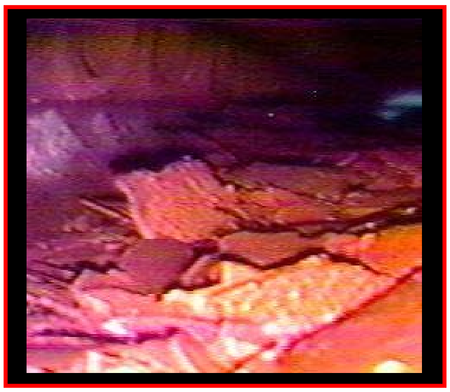


Electromagnetic Wave Form
Source: Clearwater Systems (1)

Removal of Existing Scale?

One of the more remarkable benefits of using pulse-power water treatment is its ability to remove existing scale (see photo below). When these systems are installed on a system with a history of scale problems, customers are *cautioned* to check their filters, traps and sumps for chunks of scale that often fall off in the weeks immediately following an installation. This may occur very rapidly (within one week) or gradually depending on the type of equipment, the composition of the scale and a variety of other factors. There are a couple of theories as to why this happens:

- Crack propagation: Under normal conditions, existing scale develops minute cracks due to the expansion and contraction of the material beneath it (especially boilers). These cracks weaken the scale until the minerals in the water replenish and strengthen it. When the pulse-power system is installed, the minerals are no longer attracted to the existing scale; they now precipitate out in the form of powder. Consequently, the scale becomes weakened to the point that the force of the water moving across its surface is sufficient to dislodge it.



Boiler scale removed by crack propagation, Source: Clearwater Systems (1)

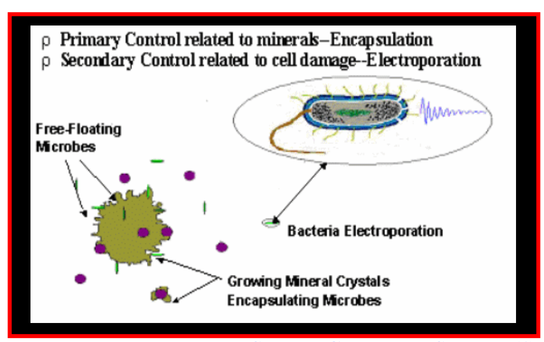
- Dissolution: When cracks develop in the scale, the treated water penetrates the scale. Because the molecular charge of the water has been altered, the calcium in the scale is attracted to the nucleation sites within the water and becomes part of the calcium carbonate powder. This further weakens the integrity of the scale.

Microbial Control

Pulse-power technology is the basis for cold pasteurization -- a FDA approved technique used in the food industry to pasteurize fluids such as fruit juices. Microorganisms contained in the juices are eliminated through exposure to high levels of electromagnetic radiation. However, the energy flux levels used in this process are at least 100 times higher than the levels for cooling tower water treatment.

Pulse-power systems used for cooling tower water treatment are not true bactericides. Instead, they *control* microbe populations by limiting their ability to reproduce. This is accomplished through two mechanisms:

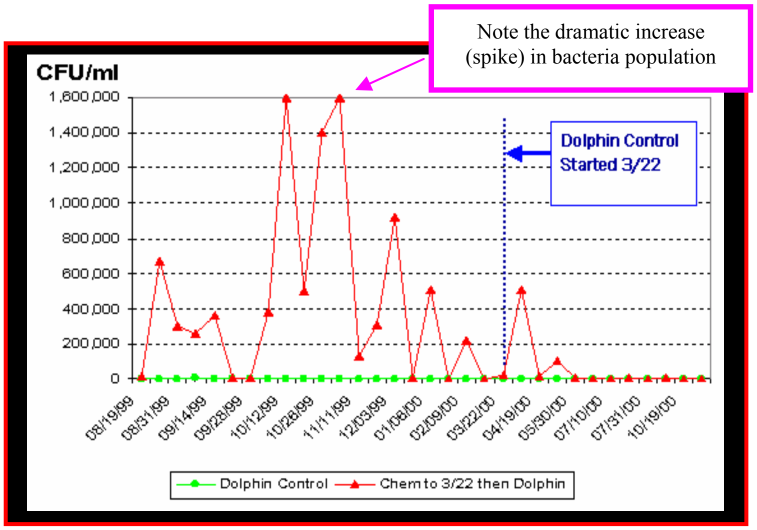
- Encapsulation: when calcium carbonate precipitates into a bulk solution, it encapsulates (surrounds) the bacteria. Although the bacteria constrained within the powder is still alive, it is unable to reproduce.



Source: Clearwater Systems (1)

The information, statements, representations, graphs and data presented in this report are provided by SMUD as a service to our customers. SMUD does not endorse products or manufacturers. Mention of any particular product or manufacturer in this report should not be construed as an implied endorsement.

- Electroporation: since cooling tower water is re-circulated within the system, the bacteria are repeatedly exposed to low levels of electromagnetic energy. This causes damage to the cell walls. Although the damage is not enough to kill the bacteria, it inhibits their ability to reproduce. The amount of bacteria in water is measured using standardized tests. The goal for most chemically treated towers is a Total Bacteria Count of between 20,000 and 50,000 CFU/ml.

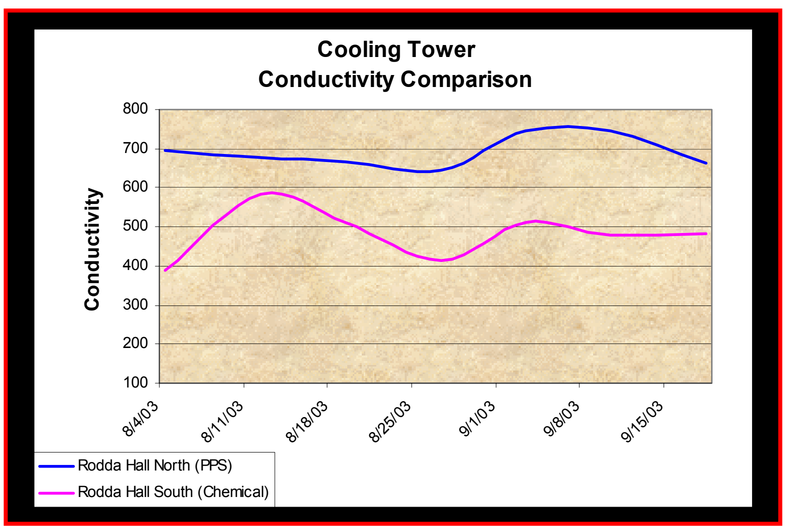


Source: Clearwater Systems (1)

When chemicals are used for biological control, bacteria population levels often vary considerably and may 'spike' (shown on the left). This is especially true if the biocides are manually applied in batches (instead of using automated feed pumps). Finally, bacteria can become resistant to the chemicals being used. For this reason, the type of biocide used must periodically be changed.

Corrosion Protection

Calcium carbonate is a cathodic corrosion inhibitor. Because of this, pulse-power water treatment systems control corrosion indirectly by operating the towers at higher pH levels (typically from 8 to 9). Since the scale-causing minerals are kept in suspension, the conductivity controllers need to be adjusted to operate the tower at higher conductivity levels (aka "cycle-up"). Although this change will undoubtedly be uncomfortable for tower operators accustomed to chemical treatment, it is necessary to provide corrosion protection (and save water). The graph shown at the right depicts the measured conductivity levels for two identical cooling towers at Sacramento City College. The cooling tower for Rodda Hall North (blue line) is treated using a pulse-power system. The other tower, Rodda Hall South (purple line), is treated using conventional chemicals.



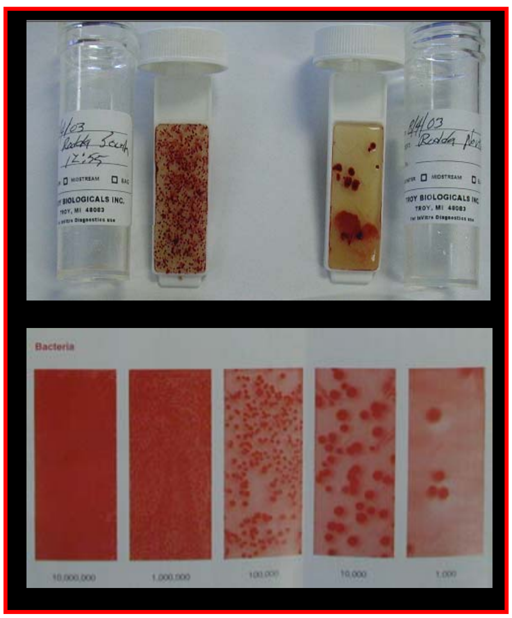
Source: BWI Solutions, Inc. (2)

Showcase Project

Project: **Sacramento City College**
3835 Freeport Boulevard
Sacramento, CA 95822

Background: In the spring of 2002, the Los Rios Community College District installed two identical 239-ton cooling towers to serve two administration buildings at Sacramento City College. Since these two buildings, Rodda Hall North and Rodda Hall South, are remarkably similar in all aspects - size, construction, age and usage, they presented an excellent opportunity to test and compare pulse-power technology against conventional chemical water treatment. The tower for Rodda Hall South is chemically treated, while the Rodda Hall North tower uses a Dolphin pulse-power water treatment system from Clearwater Systems. An independent water treatment company, BWI Solutions Inc., was hired to test, monitor and evaluate the performance of both towers.

Cooling Tower for Rodda Hall North



Bacteriological plate counts. Notice the dramatic difference between the chemically treated tower (left side of photo) and the pulse-power treated tower (right side). Source: BWI Solutions, Inc. (2)

What Was Tested? Both towers have now been in operation for over one year and have undergone extensive testing, including:

- ❑ Bacteriological plate counts
- ❑ Physical inspections of the towers and the chiller condenser tubes.
- ❑ Corrosion coupons
- ❑ Conductivity level monitoring (sensors)
- ❑ Water analysis
- ❑ Water metering (Rodda Hall North)
- ❑ Electrical measurements (to determine the electrical consumption of the Dolphin system).

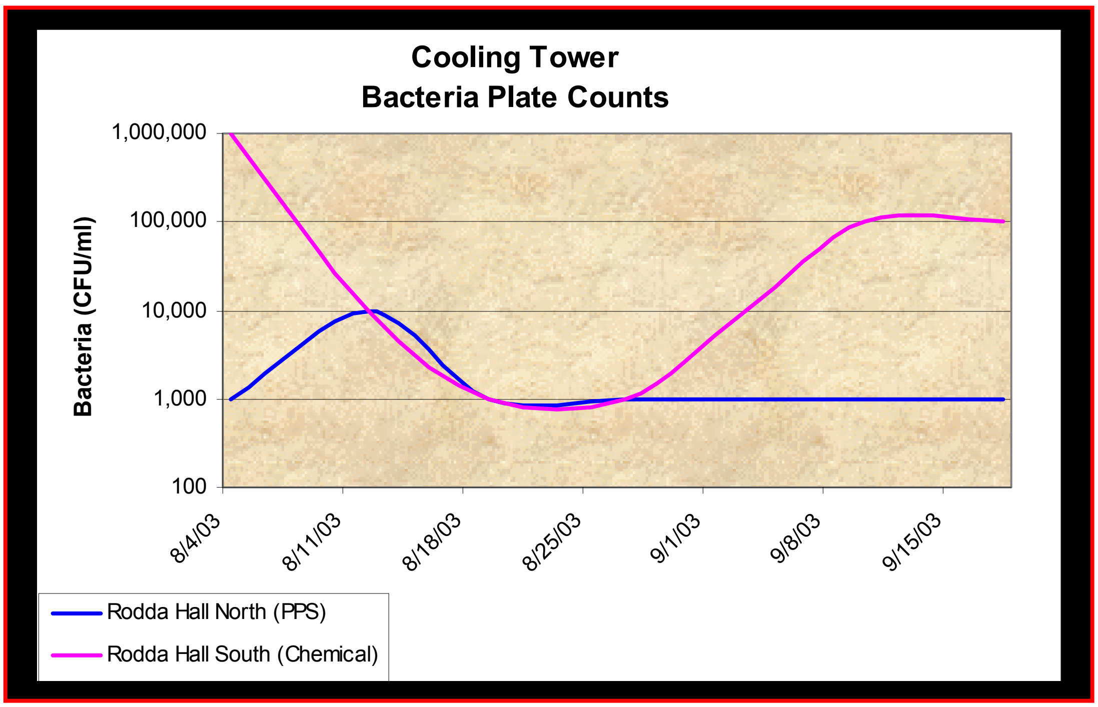
Water samples, corrosion coupons, water meter readings, electrical metering data and physical inspections were all used to evaluate the performance of both water treatment options.

Summary of Test Results

Microbial Control

Water samples were collected from the basins of the two towers and tested. The Rodda Hall North (pulse-power system) tower operated at a weekly average of ***15 cycles of concentration***. The Total Bacteria Count ranged from a low of less than 1,000 CFU/ml to a high of 10,000 CFU/ml (see chart below).

During the same period, the Rodda Hall South (chemically treated) tower operated at an average of between 5.6 cycles of concentration, and experienced a significant spike in bacterial growth. *As shown below, the Total Bacteria Count on August 4 was over 1,000,000 CFU/ml*. The water treatment company was subsequently notified and added biocides to shock the tower water. This reduced the Total Bacteria Count to 10,000 CFU/ml.



Source: BWI Solutions, Inc. (2)

Inspections

Both cooling towers and chiller condenser tubes were visually inspected on several occasions. Although both systems were essentially free from scale, it is important to remember that the towers were operated at significantly different cycles of concentration.

Corrosion Tests

The chemically treated cooling tower steel coupons achieved passivation (formed a protective layer needed to achieve lower corrosion rates) within the first 5 days with measured corrosion rates not exceeding 1.6 mils per year (mpy) and dropping to 0.40 mils per year within 30 days. The pulse-power system had higher initial corrosion rates of 7.8-7.3 mils per year but dropped to 3.1 mpy within 30 days and to 1.9 mpy within 60 days. Passivation occurred between the 15 day and 30 day samples for the pulse-power treated system.

The copper coupons from both treatment technologies indicated similar results: 0.24 mils per year (pulse-power) and 0.29 mils per year (chemical) after 30 days. The pulse-power system appeared to passivate the copper coupons slightly faster.

Water Consumption

Water meters were not installed in the chemically treated cooling tower due to cost considerations. Therefore, water use rates were calculated for Rodda South based on conductivity derived cycles of concentration. Evaporation of the cooling towers was assumed to be identical since the chillers, facilities and cooling towers are identical and the buildings experience similar occupancy loads. The Los Rios Community College District controls both systems with a central building management system.

The pulse-power system yielded significant water savings compared to the chemically treated tower. During the study period the pulse-power system saved an estimated *2,253 gallons per week* of make-up water by providing a *68%* reduction in blow-down.

Location / parameter	Average Blow-down (gallons per week)	Average Make-up Water (gallons per week)	Average Weekly Cycles of Concentration
Rodda Hall South Cooling Tower (chemically treated)	3,339	18,553	5.6
Rodda Hall North Tower (pulse-power treated)	1,084	16,299	15.0
Water Savings Per Week	2,254	2,254	
Reduction In Water Consumption (%)	**68%**	**12%**	

Source: BWI Solutions, Inc. (2)

Financial Summary

When calculating savings, it is important to consider the following potential benefits:

- Avoided chemical costs
- Reduced water consumption
- Reduced maintenance (scale prevention, no chemical feed pumps to maintain or switch over)
- Increased cooling tower and chiller efficiency (prevention and removal of existing scale)
- Enhanced safety--no need to store, handle or use hazardous water treatment chemicals
- More environmentally friendly than chemical treatment; may avoid costly environmental fees and penalties

The calculations presented below are based *solely* upon avoided chemical costs, water savings and the cost of power required to operate the pulse-power system. Although the additional benefits may provide significant savings, there is not sufficient available data to estimate their potential value. Since the cooling towers for Rodda Hall North and Rodda Hall South are identical, the water treatment costs for each tower will be compared to estimate the savings for this project.

Water treatment cost = (cost of chemicals) + (water costs) – (energy costs to operate system)

- Project cost = $14,000*
- R & D grant = $4,000
- Net project cost = $10,000
- Annual Savings = $1,677
- Simple payback = 5.9 years

Water Treatment Cost Comparison	Rodda Hall North (pulse-power)	Rodda Hall South (chemical treatment)
Chemicals	$0	$1,700
Water	$563	$640
Energy[1]	$125	$25
Total	$688	$2,365

[1] Chiller and tower fan not included in energy cost

* Includes cost of water meters and monitoring equipment

Observations

Pulse-power treatment system results:

- Higher system conductivity, alkalinity and hardness levels with lower turbidity values than the chemically treated tower.

- Ability to operate at significantly higher cycles of concentration than the chemically treated tower. Cycles of concentration (make-up ÷ blow-down averaged **15.0** for the pulse-power system versus **5.6** for the chemically treated tower.)

- High cycles of concentration amplified the naturally occurring Phosphonate levels to concentrations nearly as high as the chemically treated tower.

- Significant water savings compared to the chemically treated tower. During the study period the pulse-power system saved an estimated 2,253 gallons per week of make-up water by providing a **68% reduction** in blow-down.

- Consistently much lower bacteria, fungi and yeast levels than the chemically treated tower. Bacterial levels were generally 1,000 CFU/ml with little or no yeast/fungi.

- At the end of the operating season, the Dolphin equipped tower had a thin residue on the underwater surfaces and powder on the air inlet louvers. The residue and powder were formed by the precipitation of calcium carbonate and contained dead bacteria, dirt and pollen.

  It is important to note that both the residue and powder were very easy to remove and will be washed off during regular preventative maintenance year-end cleaning (see photos).

Photo of residue

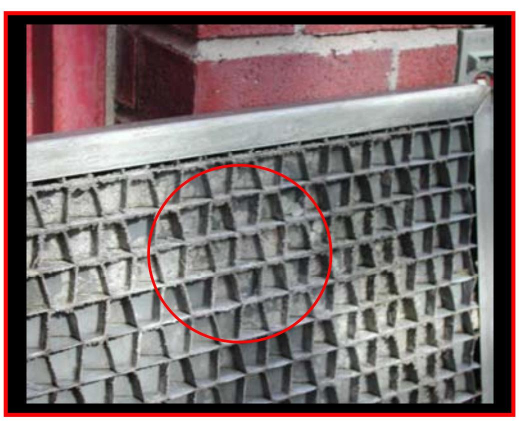


Photo of powder residue

Photo taken after briefly rinsing with a water hose

Chemically treated tower results:

- Higher variability in pH, conductivity, and bacteria levels due to batch application of biocides. Although the control equipment was installed to automatically feed the biocide, the odor from the open biocide in-service biocide container was not acceptable to the Sacramento City College maintenance staff, and therefore, not used.

- Lower alkalinity, hardness and silica levels due to lower cycles of concentration.

Other observations:

- Neither of the cooling towers experienced silica levels near the silica saturation point (180 ppm). The highest recorded silica level for the pulse-power treatment system at Rodda North was 100 ppm. The chemically treated tower did not exceed 60 ppm silica during the study. Since the saturation point was not reached during this study, the ability to control silica scale above the saturation point was not determined.

- The chlorides measurement did not prove to be a meaningful measurement of system cycles in this study. The chlorides test used provided only 10 ppm resolution. The make-up water at Rodda North and Rodda South had low chloride levels in the 10-20 ppm range, causing the test resolution to induce inaccuracies in the cycles calculation based on chloride measurements. Therefore, water meter data (from Rodda North), conductivity readings, and cooling load data were used to calculate cycles of concentration for the Rodda Hall South tower.

- During the test period neither of the towers were analyzed for the presence of Legionella bacteria. *To our knowledge, no organization or industry trade group has yet evaluated pulse–power water treatment effectiveness at controlling Legionella.*

"The economic benefits of the Dolphin non-chemical water treatment are compelling. Perhaps more compelling are the ancillary benefits not included in the cost analysis such as water conservation, environmental mitigation, reduced administrative costs, and reduced effort required by District technicians."

Mike Goodrich
Director of Energy/Utility Services
Los Rios Community College District

Conclusions

Pulse-power water treatment systems may provide both direct and indirect cost benefits.

Direct Benefits

- Reduced water consumption and disposal costs

- Avoided chemical costs

- Reduced maintenance (scale prevention, no chemical feed pumps to maintain or switch over)

- Increased cooling tower and chiller efficiency (prevention and removal of existing scale)

Indirect Benefits

- ❑ Enhanced safety--no need to store, handle or use hazardous water treatment chemicals
- ❑ More environmentally friendly than chemical treatment

Challenges

- ❑ Perhaps the most significant challenge facing this technology is establishing credibility. Many other past attempts to develop effective non-chemical water treatment (NCWT) systems have failed. Consequently, there is a great deal of skepticism about NCWT systems.
- ❑ Relatively new technology – no established long-term reliability or maintenance records.

Set It & Forget It?

All too often, we rely too heavily upon technology to cure all of our ills. Although pulse-power water treatment technology offers an alternative to chemical water treatment, it must be combined with good maintenance and installation practices to be completely effective. Regardless of how you treat your water, you should consider the following recommendations:

- ❑ Drain, clean, inspect and repair cooling towers at least once annually
- ❑ If the cooling tower is used only on a seasonal basis, be sure to follow your water treatment company's guidelines for water circulation during the off-season.
- ❑ Use high quality conductivity controllers and clean the sensors on a bi-weekly basis.
- ❑ Consider using software to continuously monitor the tower conditions
- ❑ Install water meters on the make-up and bleed lines and track your consumption
- ❑ Consider installing a full port ball valve instead of a solenoid valve in the tower blow-down line to prevent clogging.

Recommendations

Not all non-chemical water systems are created equal. Customers should ask vendors to provide references and empirical data (e.g. water test results, bacterial plate counts) and then take the time to follow up on them.

Technology Transfer

Pulse-power water treatment systems are commercially available and are continuing to gain acceptance in the HVAC industry. Cooling tower manufacturers and distributors should consider offering pulse-power water treatment systems as a factory installed option for customers seeking an alternative to chemical water treatment. This would help leverage existing business relationships, provide more options and reduce costs for cooling tower customers.

Use of this technology for other water treatment applications such as boilers, decorative water fountains, and pools should be explored through additional demonstration projects.

References

We gratefully acknowledge the contributions made from the Los Rios Community College District, BWI Solutions Inc., Precision Environmental & Power, and Pat Kemper (SMUD Editor).

1) "Operating Principles: Methods of Action," Clearwater Systems LLC, available at http://www.clearwater-dolphin.com/operating_principles.htm

2) BWI Solutions Inc., 5549 Luce Avenue, McClellan, CA 95652-2416. tel: (916) 922-7028, fax: (916) (916) 922-7143, http://www.bwisolutions.com